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L2	3006	(primary or second\$4 or master or backup or back-up or (back adj up) or mirror or redundan\$3 or double) with snapshot	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:03
L3	5	L2 same 1	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:03
L4	43588	recover\$4 same protect\$4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:03
L5	1868	writ\$4 same 1	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:04
L6	145780	(a adj point adj in adj time) or PIT or APIT or (point adj in adj time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:04
L7	148	(rewound or rewind\$3) same (L6 or (any adj point adj in adj time) or "any point in time")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:06
L8	4	5 same 4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR .	ON	2007/05/23 13:06

L9	0	7 and 4 and 5	US-PGPUB;	OR	ON	2007/05/23 13:06
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L10	1	5 and 2 and 7	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:07
L11	0	7 same mapp\$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:07
L12	791	(714/42).ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR .	ON	2007/05/23 13:07
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L14	577	(714/13).ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:07
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L16	992	(714/2).ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:08

L17	1081	(714/5).ccls.	US-PGPUB;	OR	ON	2007/05/23 13:09
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L24	. 0	22 and 7 and 4 and ("707"/\$).ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:10
L25	637	(duplicat\$3 or double) adj write	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:10

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L26	6	(mapp\$3 or mirror or redundan\$3 or double) same (primary or second\$4 or first or backup or back-up) same volumn	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:10
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S5	2394	(primary or second\$4 or master or backup or back-up or (back adj up) or mirror or redundan\$3 or double) with snapshot	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/06 15:36
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S8	4	S1 and S5 and S6	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/05 07:24
S9	54	S5 and S6	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/05 07:24
S10	20	S9 and recover\$4 and continuous\$4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/05 07:25
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S22	1	"20050010529".PN.	US-PGPUB	OR	ON	2006/07/05 12:01
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S28	2	S27 and S24	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/05 12:43
S29	20	S27 and recover\$4 and continuous\$4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/05 12:44
S30	31	S27 not (S23 or S29)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR ·	ON	2006/07/05 12:44
S31	36	S27 and map\$4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/05 13:09

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S32	21	S31 and recover\$4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/05 13:09
S33	0	S32 not (S29 or S30)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/05 14:35
S34	590	(duplicat\$3 or double) adj write	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/01/03 11:06
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S36	368	S34 same (mapp\$3 or mirror or redundan\$3 or double)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR .	ON	2006/07/06 15:38
S37	2	S36 same rewound\$4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/06 15:39
S38	2402	(primary or second\$4 or master or backup or back-up or (back adj up) or mirror or redundan\$3 or double) with snapshot	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/06 15:39
S39	138555	(a adj point adj in adj time) or PIT or APIT or (point adj in adj time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/06 15:39

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S43	, 429	(714/8).ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/06 15:43
S44	110	delta adj map\$4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/06 15:44
S45	6	S44 and S38 and S39	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/07/07 09:08
S46	2	("20050010529").PN.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2006/07/07 09:08

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S50	4	(rewound or rewind\$3) near3 (S49 or (any adj point adj in adj time) or "any point in time")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/05/23 13:04

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S51	3	S48 same S49	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/01/03 11:00
S52	4221	(duplicat\$3 or double) near2 writ\$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/01/03 11:13
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S54	111	S48 and S49	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/01/03 11:07
S55	7	S54 and S52	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/01/03 11:08
S56	2	S54 and S53	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/01/03 11:09
S57	0	S54 and S47	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON ,	2007/01/03 11:09
S58	6691	(duplicat\$3 or replicat\$3 or mirror\$3 or double) near2 writ\$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/01/03 11:13

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S59	743	(714/42).ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/01/03 11:24
S60	982	(714/15).ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/01/03 11:27
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S67	982	(714/15).ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/01/03 11:27
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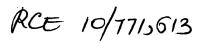


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TRAP-Array: A Disk Array Architecture Providing Timely Recovery to Any Point-in-time

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Abstract

 ∇

RAID architectures have been used for more than two decades to recover data upon disk failures. Disk failure is just one of the many causes of damaged data. Data can be damaged by virus attacks, user errors, defective software/firmware, hardware faults, and site failures. The risk of these types of data damage is far greater than disk failure with today's mature disk technology and networked information services. It has therefore become increasingly important for today's disk array to be able to recover data to any point in time when such a failure occurs. This paper presents a new disk array architecture that provides timely recovery to any point-in-time, referred to as TRAP-array. TRAP-array stores not only the data stripe upon a write to the array, but also the time-stamped exclusive-ORs of successive writes to each data block. By leveraging the exclusive-OR operations that are performed upon each block write in today's RAID4/5 controllers, TRAP does not incur noticeable performance overhead. More importantly, TRAP is able to recover data very quickly to any point-intime upon data damage by tracing back the sequence and history of exclusive-ORs resulting from writes. What is interesting is that TRAP architecture is amazingly space-efficient. We have implemented a prototype TRAP architecture using software at block device level and carried out extensive performance measurements using TPC-C benchmark running on Oracle and Postgress databases, TPC-W running on MySQL database, and file system benchmarks running on Linux and Windows systems. Our experiments demonstrated that TRAP is not only able to recover data to any point-in-time very quickly upon a failure but it also uses less storage space than traditional daily differential backup/snapshot. Compared to the state-of-the-art continuous data protection technologies, TRAP saves disk storage space by one to two orders of magnitude with a simple and a fast encoding algorithm. From an architecture point of view, T- RAP-array opens up another dimension for storage arrays. It is orthogonal and complementary to RAID in the sense that RAID protects data in the dimension along an array of physical disks while TRAP protects data in the dimension along the time sequence

Index Terms Inspec

Controlled Indexing

RAID back-up procedures security of data system recovery

Non-controlled indexing

Linux MySQL database Oracle database Postgress databases RAID architectures TPC-C benchmark TRAP architecture TRAP-array Windows systems data damage data protection technology defective software/firmware disk array architecture disk failures disk storage space disk technology file system benchmarks hardware faults networked information services site failures user errors virus attacks

Author Keywords Not Available

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Compiler construction: an advanced course

F. L. Bauer, F. L. De Remer, M. Griffiths, U. Hill, J. J. Horning, C. H. A. Koster, W. M. McKeeman, P. C. Poole, W. M.

January 1974 Book

Publisher: Springer-Verlag New York, Inc.

Full text available: pdf(65.62 MB)

Additional Information: full citation, abstract, references, cited by

The Advanced Course took place from March 4 to 15, 1974 and was organized by the Mathematical Institute of tl the Leibniz Computing Center of the Bavarian Academy of Sciences, in co-operation with the European Communi Research and Technology of the Federal Republic of Germany and by the European Research Office, London.

Selected writings on computing: a personal perspective

Edsger W. Dijkstra January 1982 Book

Publisher: Springer-Verlag New York, Inc.

Full text available: pdf(60.98 MB)

Additional Information: full citation, abstract, references, cited by, index term

Since the summer of 1973, when I became a Burroughs Research Fellow, my life has been very different from w routine changed: instead of going to the University each day, where I used to spend most of my time in the com one day a week and was most of the time that is, when not travelling!-- alone in my study. In my solitude, mail more and more important. The circumstance that my employe ...

The multics system: an examination of its structure

Elliott I. Organick January 1972 Book Publisher: MIT Press

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Third Generation Computer Systems

Peter J. Denning

December 1971 ACM Computing Surveys (CSUR), Volume 3 Issue 4

Publisher: ACM Press

Full text available: pdf(3.52 MB)

Additional Information: full citation, abstract, references, citings, index term

The common features of third generation operating systems are surveyed from a general view, with emphasis or constitute at least the basis for a "theory" of operating systems. Properties of specific systems are not discussed technical aspects of issues and concepts are stressed, the nontechnical aspects mentioned only briefly. A perfunc systems is presumed.

Genesis: a distributed database operating system

May 1985

Thomas W. Page, Matthew J. Weinstein, Gerald J. Popek

ACM SIGMOD Record, Proceedings of the 1985 ACM SIGMOD international conference or

Volume 14 Issue 4 Publisher: ACM Press

Full text available: pdf(1.48 MB)

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Pen computing: a technology overview and a vision

André Meyer

July 1995

ACM SIGCHI Bulletin, Volume 27 Issue 3

Publisher: ACM Press

Full text available: pdf(5.14 MB)

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This work gives an overview of a new technology that is attracting growing interest in public as well as in the cor difference from other technologies is in the use of a pen or pencil as the primary means of interaction between a familiar pen and paper interface metaphor. From this follows a set of consequences that will be analyzed and put technologies and visions. Starting with a short historic ...

Loopback recovery from double-link failures in optical mesh networks

Hongsik Choi, Suresh Subramaniam, Hyeong-Ah Choi

December 2004 IEEE/ACM Transactions on Networking (TON), Volume 12 Issue 6

Publisher: IEEE Press

Full text available: pdf(505.00 KB)

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161 Performing remote operations efficiently on a local computer network

Alfred Z. Spector

April 1982 Communications of the ACM, Volume 25 Issue 4

Publisher: ACM Press

Full text available: pdf(1.58 MB)

Additional Information: full citation, abstract, references, citings, index term

A communication model is described that can serve as a basis for a highly efficient communication subsystem fo taxonomy of communication instructions that can be implemented efficiently and can be a good basis for interpre communication instructions, called remote references, cause an operation to be performed by a remote process returned. This paper also presents implementation considerati ...

Keywords: communication models, efficient communication, transactions

162 Potpourri: Fast and transparent recovery for continuous availability of cluster-based servers

Rosalia Christodoulopoulou, Kaloian Manassiev, Angelos Bilas, Cristiana Amza

Proceedings of the eleventh ACM SIGPLAN symposium on Principles and practice of para March 2006

Publisher: ACM Press

Full text available: pdf(111.02 KB)

Additional Information: full citation, abstract, references, index terms

Recently there has been renewed interest in building reliable servers that support continuous application operation consistent after a failure, one of the main challenges in achieving continuous operation is to provide fast reconfig reconfiguration mechanisms employed and their overheads depend on the type of platform that is being used as that need to be supported. In this paper we foc ...

Keywords: availability, distributed shared memory, fast failure reconfiguration, fault tolerance, scalability

163 Multithreading I: Master/slave speculative parallelization

Craig Zilles, Gurindar Sohi

November 2002 Proceedings of the 35th annual ACM/IEEE international symposium on Microarchitecture

Publisher: IEEE Computer Society Press

Full text available: pdf(1.31 MB) Publisher Site

Additional Information: full citation, abstract, references, citings, index term

Master/Slave Speculative Parallelization (MSSP) is an execution paradigm for improving the execution rate of sec speculatively for execution on a multiprocessor. In MSSP, one processor---the master---executes an approximat

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